

EMC Mainframe 'Tape on Disk' Solutions

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Mainframe Tape Solutions Team

Feb 22, 2011



zMainframe

Never trust a computer you can lift!

Agenda

- Bus-Tech, Inc. Introduction
 - EMC Partnership & BTI Acquisition
- EMC Tape-on-Disk Solutions
 - DLm
 - DLm & Data Domain Deduplication
 - MDL & DD (*DeDup Only*)
- Tape Assessment Analysis
- Migration, & Implementation

Bus-Tech, Inc.

Statistics

- Founded in 1987
- Key Industry OEM Supplier
- Over 32,000 Channel Interfaces shipped
- Tape on Disk Controllers introduced in 2002
 - Mainframe Appliance for Storage (MAS)
 - Mainframe Data Library
- Over 1000 VTL Controllers installed in 17 Countries Worldwide
- zSeries Certified
- Original Management Team
- Privately Held
- ISO 9001 2000 Certified

Facilities

- Bedford, MA USA
 - Manufacturing
 - Administration
 - Marketing
 - Engineering and Design
 - Customer Support
 - Quality
- Raleigh, NC USA
 - Engineering and Design
- Sales Offices
 - Boston
 - Dallas
 - Chicago
 - Los Angeles
 - London

Bus-Tech & EMC Partnership

- May 2002 BTI announces MAS
- June 2003 BTI announces support for EMC Centera
- December 2004 MAS available through EMC Select
 - Celerra, Clariion, Centera
- August 2006 BTI announces MDL
- July 2008 BTI Completes Testing Under The IBM System Storage Proven™ Program
- August 2008 Bus-Tech was named "Best in Encryption for Mainframe" and "Best in Mainframe Disaster Recovery" for 2008 from a global field of nominations.
- February 2008 – EMC announces DLm (Disk Library for Mainframe)
 - Bus-Tech OEM Solution
- November 2010 EMC acquires BTI

EMC Acquires Bus-Tech

- 6 year partnership culminates into acquisition
 - Delivered Mainframe VTL since 2002
- People, partnership, and technology considered strategic
 - Mainframe expertise, channel technology
- Product line rationalization
 - Bus-Tech MDL and EMC DD
- MDL Virtuent 7 is Bus-Tech's current hardware platform
- Additional platform support: VM, VSE, Unisys, OS/390
- Strong message to market –
 - “EMC is in the mainframe tape business”
 - Positive endorsement by multiple analyst groups
 - “Game changer” direction



EMC Mainframe Tape Leadership

- First major vendor to offer tape-on-disk exclusively
 - Tape back-end no longer required
 - Breakthrough economics with superior performance
- First major vendor to offer dedup storage for mainframe
 - DataDomain storage offered for mainframe backup, batch, HSM, and archive
- First major vendor to offer both dedup and non-dedup storage in a single solution
 - Mixed storage, customer choices, single footprint
- First major vendor to offer “real” DR test/implementation
 - Breakthrough non-disruptive DR test with “real” live data
 - Ability to replicate while testing
- First major vendor to offer cost-attractive P2P replication
 - Superior value for DR testing
 - Simplicity in replication
 - Ability to use live data for DR without replication interrupt

EMC Mainframe 'Tape on Disk' Solutions

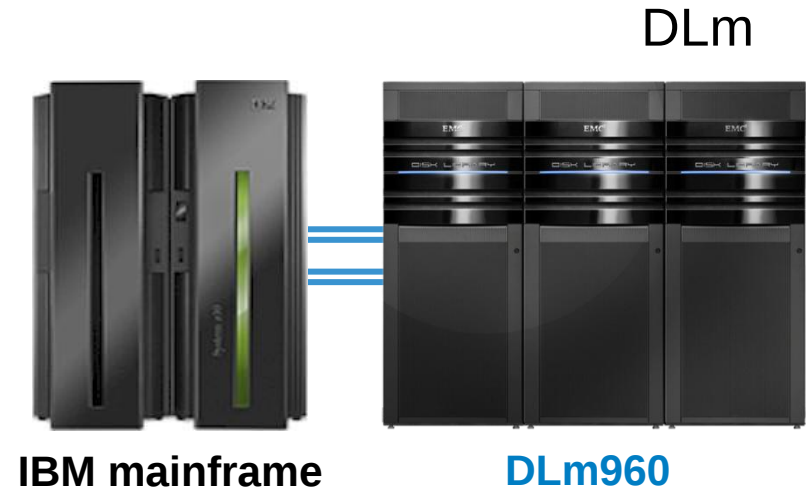
Disk Library for the Mainframe

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Driving Factors for 'Tape on Disk'

- Performance of batch processing
 - Increasing amount of data
 - 24x7 Global Environment
- Reliability and availability of tape media
 - Libraries, drives, and cartridges fail
 - Too many moving parts / too mechanical
 - Tape copies must be made (No RAID Protection)
- Management complexity
 - Constant tuning of environment
 - Thrashing of tape data in/out Virtual Tape Library
- DR complexity
 - 100's of tapes/cartridges
 - Complete Testing is impossible / Frequency Limited
- Risk associated with media management
 - Lost/Damaged tapes
 - Time to find media for reads / restores
 - Cost of transporting tapes / Expensive & cumbersome
 - Encryption standards inevitable
- Deduplication



Evolution of Mainframe Tape

1978

1988

1998

2008

Magnetic Reel

- Batch systems
- Manual tape mounting



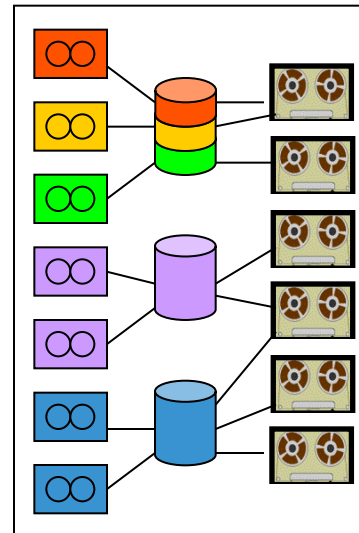
Tape Library with Cartridges

- Automated Robotics
- Faster mount times



Virtual Tape Systems

- Virtual tape drives
- Disk Buffer to Tape
- Automated Robotics

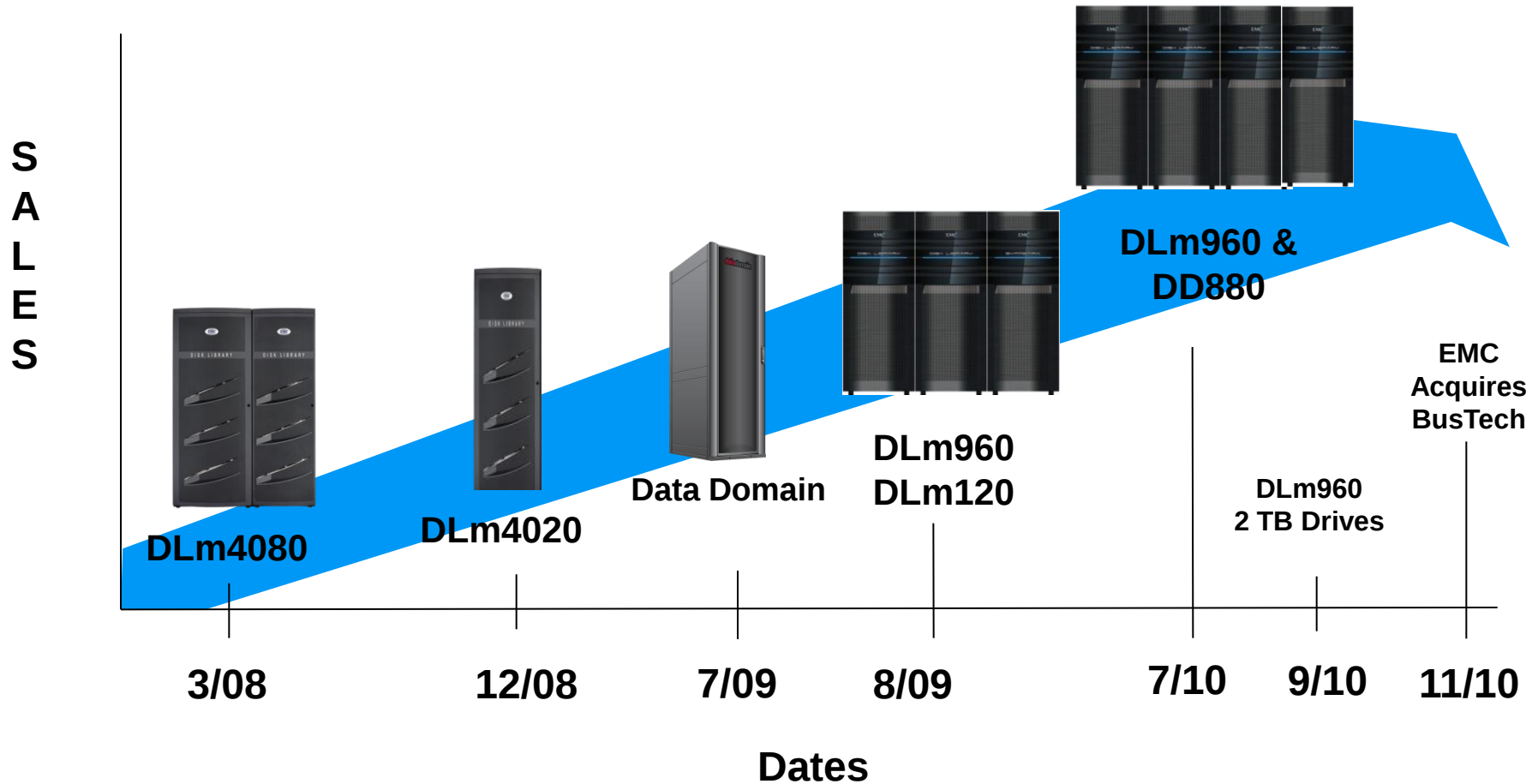


Disk Library for mainframe

- Tape on Disk
- Eliminate all tape media limitations/problems

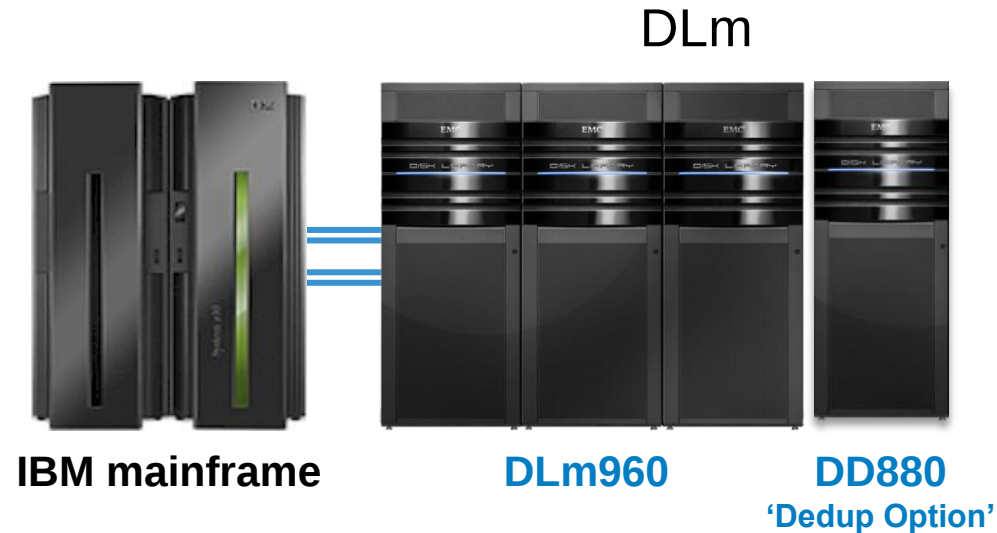


EMC 'Tape On Disk' Timeline



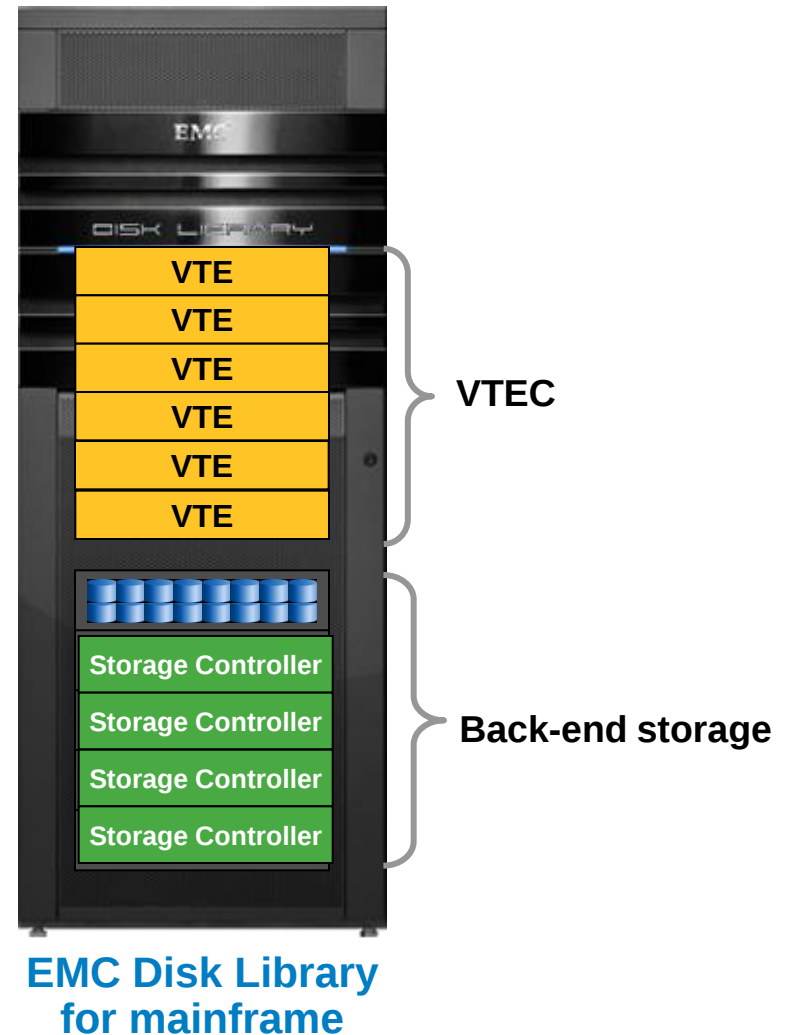
EMC 'Tape on Disk'

- Not virtual tape – but 'Tape on Disk'
- True IBM tape emulation
 - 3480, 3490, 3590
- Transparent to end users
- Leverages low cost, RAID 6 protected 1 TB & 2 TB disk technology
- High performance read and write
- Unmatched replication capability
- Industry Leading Data Domain Deduplication
- Eliminates least reliable media in the industry – 'Tape'



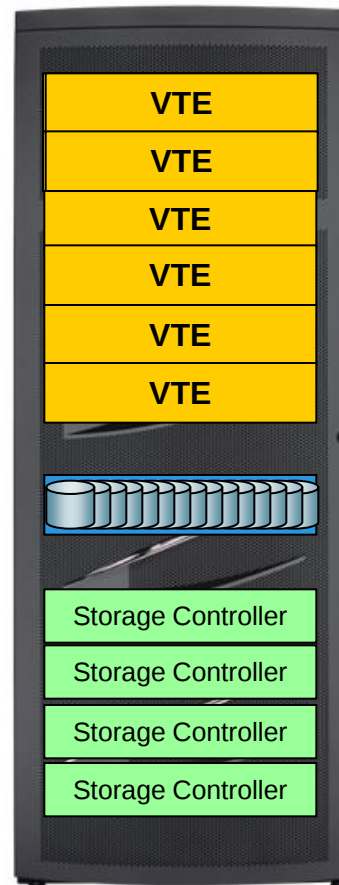
Disk Library for Mainframe Components

- Virtual Tape Emulation Controller (VTEC)
 - Includes the virtual tape engines (VTEs)
 - Emulates IBM 3480/3490/ 3590 tape drives
 - 256 tape drives per VTE
 - Up to 1,536 with six VTEs
 - FICON/ESCON connectivity
 - > 200MB/sec per VTE
 - Over 1.2 GB/s with six VTEs (FICON)
 - Transparent to mainframe TMS
 - Writes cartridges (VOLSER) as files
 - Provides unlimited virtual tape volumes
 - Virtual cartridge size up to 16 TB
 - Disk consumption is based on data written
 - Supports hardware compression
- Back-end storage
 - Leverages 1 TB or 2 TB SATA II drives
 - RAID 6 (12+2) configuration
 - Hot spare for every disk tray
 - Stores all tape images as files
 - Shares all tape volumes between all VTEs

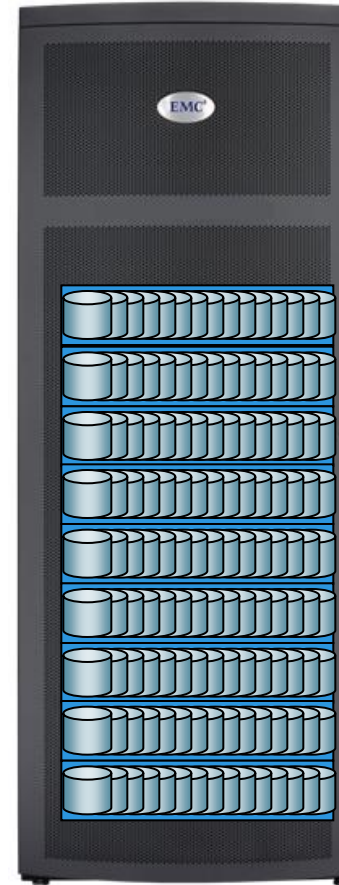


Disk Library for mainframe Scalability

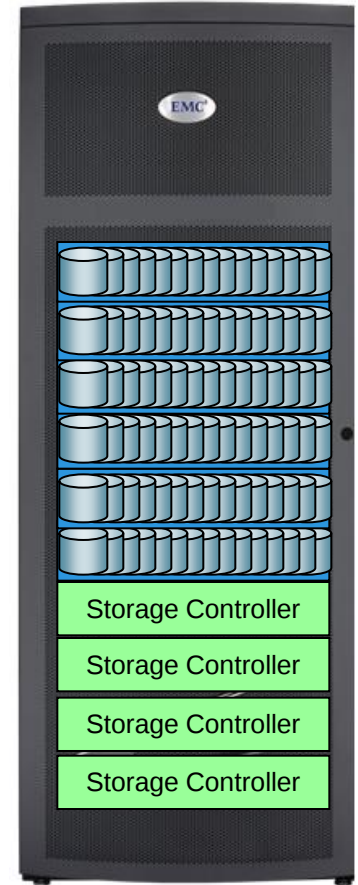
- Start small
 - 2 VTE
 - 1 DAE
 - Minimum of 9.5 TB usable capacity before IDRC compression
- Scale as needed
 - Add VTEs to support more workloads
 - Add storage in “buckets” of 9.5 or 19.3 TB
 - Non-disruptive design



Base cab



Storage cab



Expansion cab

Disk Library for Mainframe Family



DLM120

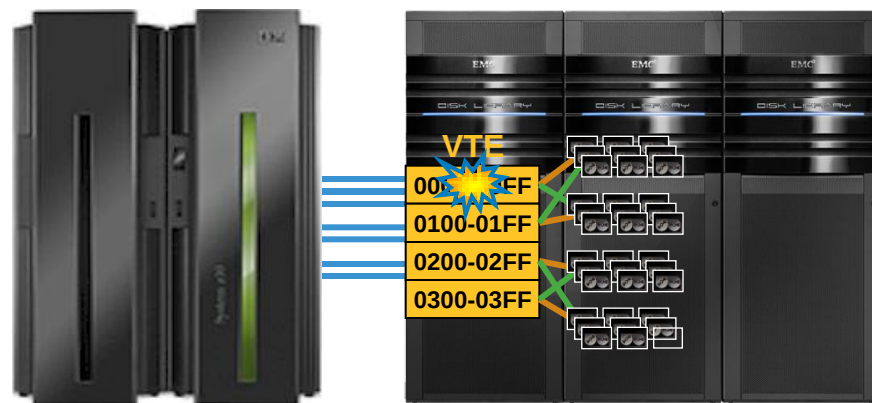


DLM960

Number of VTEs	1 or 2	1–6
Connectivity	FICON	FICON
Number of channels to host	2 or 4	2–12
Number of virtual tape drives	Up to 512	Up to 1,536
Maximum capacity (usable)	9.5 TB–96.5 TB	19.3 TB–1.2 PB
Performance	Up to 400 MB/s	Up to 1.2 GB/s
Number of cabinets	1	2–13 with 1TB 2–10 with 2TB
Replication	✓	✓
Hardware compression	✓	✓

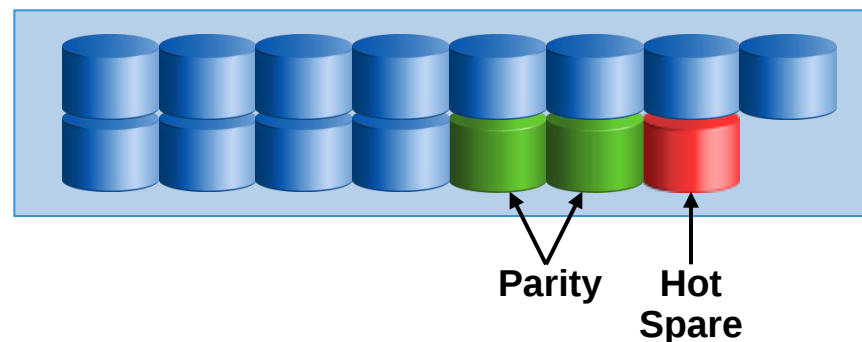
No Single Point of Failure

- All VTEs can see all tape volumes in Disk Library for mainframe
- If a VTE fails...
 - Job will fail with tape error (same as with regular tapes)
 - Tape volumes are still available
 - Tape volumes can be accessed through a different drive
 - VTE does not contain metadata
 - No tape information is lost
- Disk drives are RAID 6 protected
 - 12 + 2 protection—the best RAID protection
 - Hot spare drive in each disk tray (DAE)
- Storage controllers configured as N+1
 - One stand by to take over in case a storage controller fails



**All tape volumes
are available**

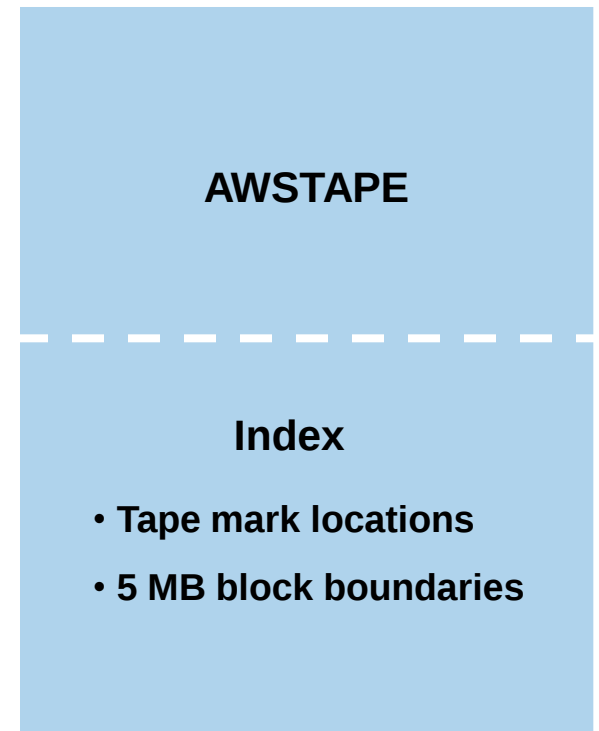
**EMC Disk Library
for mainframe**



Decrease Response Times to One Second

- Fast locate provides additional performance benefits
 - Response times drop from an average of 15 to 40 seconds to less than one second 99 percent of the time
 - Improves service level agreements
 - Immediate major benefit to applications such as ViewDirect by Mobius
- When Disk Library for mainframe writes to tape, it builds an index for fast locate
 - Index is stored at the end of the volume's disk file
 - Contains a pointer to:
 - Each tape mark (TM) location
 - Each 5 MB block boundary
 - On read, the VTE can go directly to any tape mark
- For block locates, the VTE will go to the nearest boundary and read forward or backward to find the block

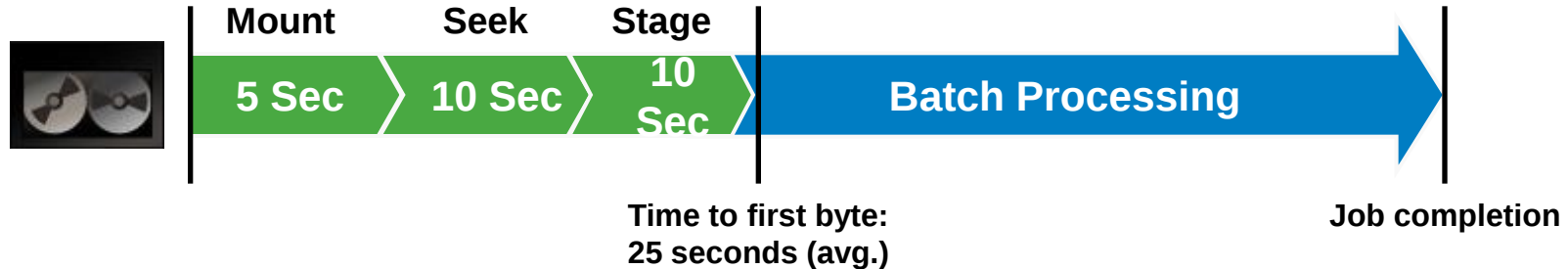
File name = Tape VOLSER



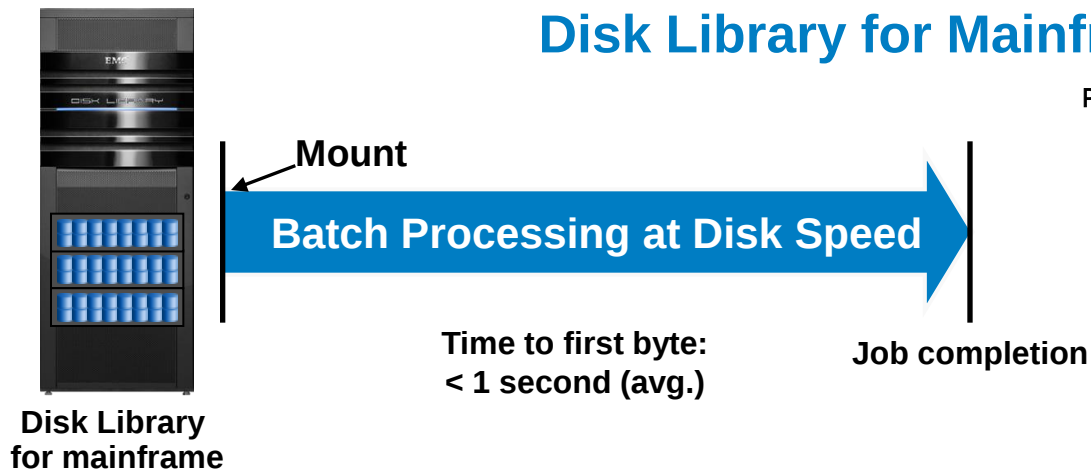
Tape image on disk

Faster Performance vs. Tapes

Tape



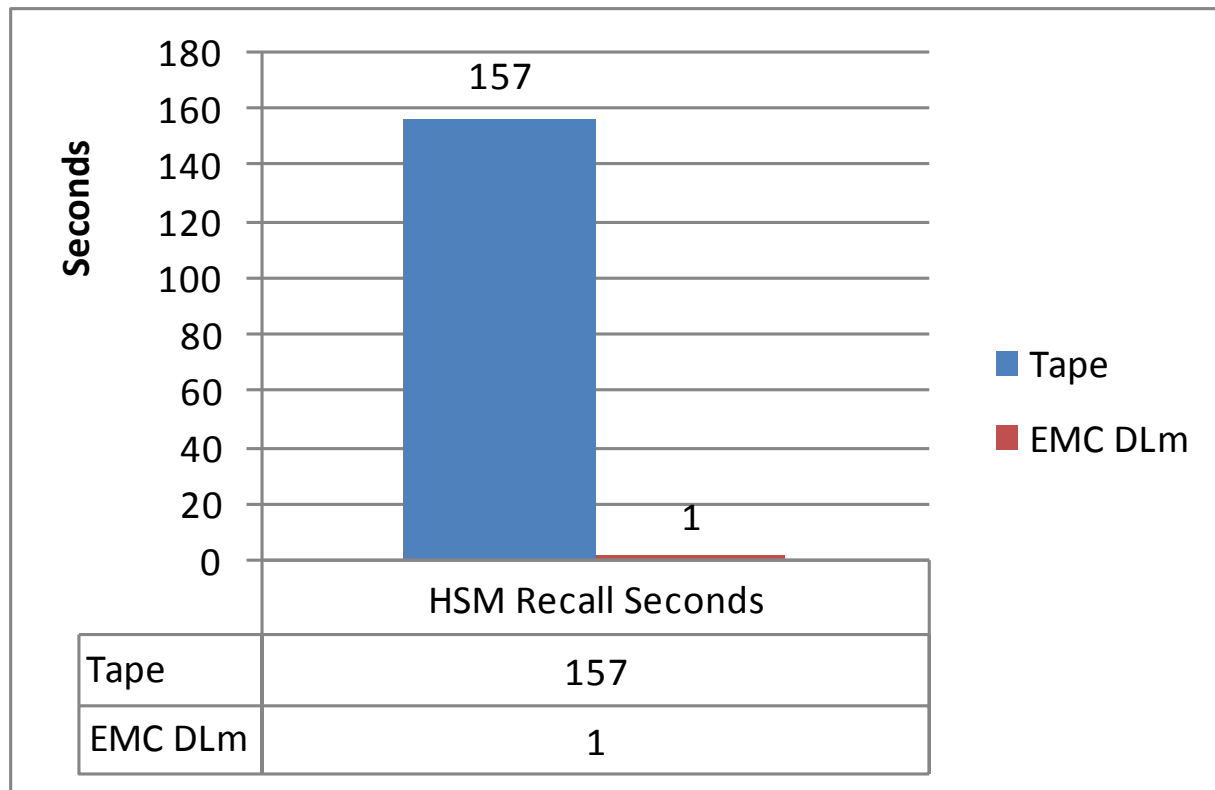
Disk Library for Mainframe



Provides...

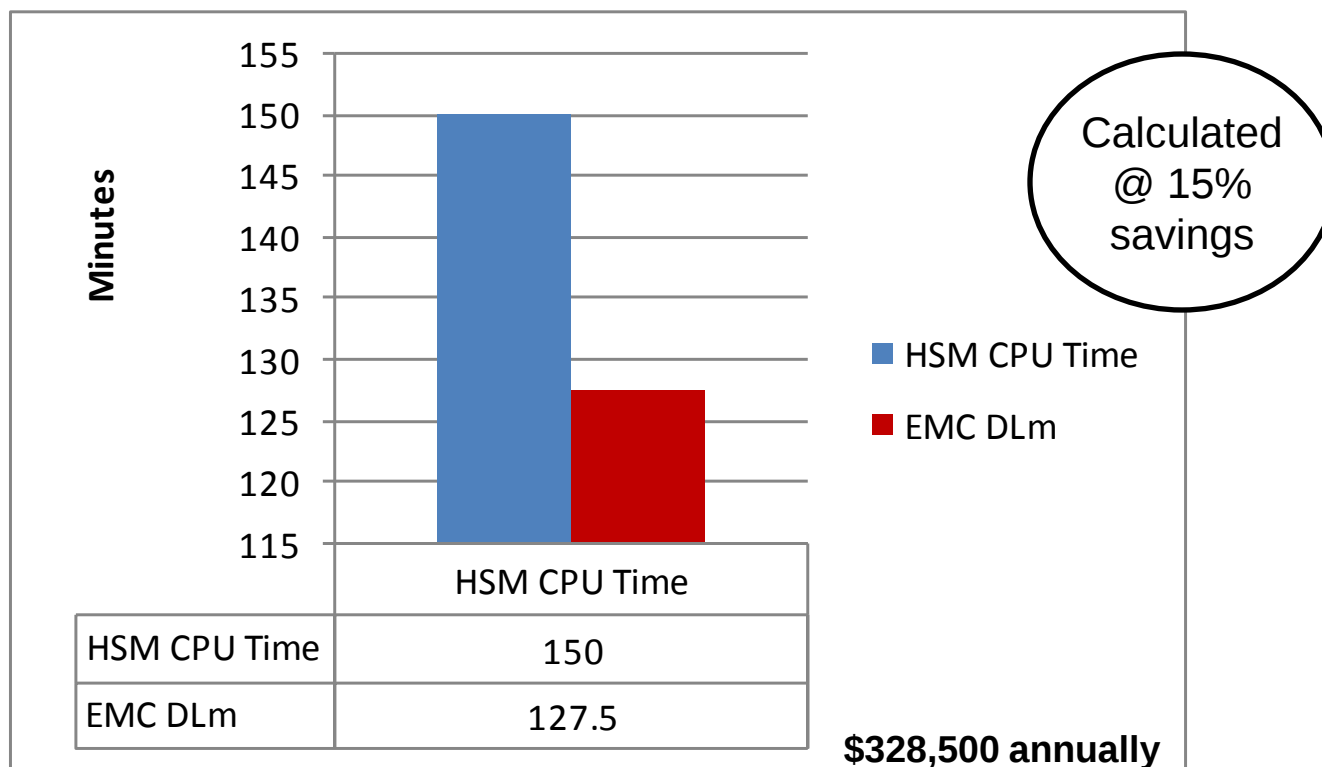
- Faster time to first byte for “all” reads
 - Less than one second mount time on average
 - No waiting for seek time for data on tape
 - No waiting for data to be staged
- Faster batch processing
 - >200 MB/s single VTE
 - >1.2 GB/s Aggregate through-put
 - Sustained performance for reads and writes

HSM Recall Seconds (ML2)



- HSM Recall Seconds the wait time to retrieve a dataset from ML2 tape.
- EMC DLm reduces this wait time to <1 second.
- Eliminate ML1, TMM pools, etc...
- **“All”** Tape reads benefit from ‘tape on disk’ access (not just ML2)

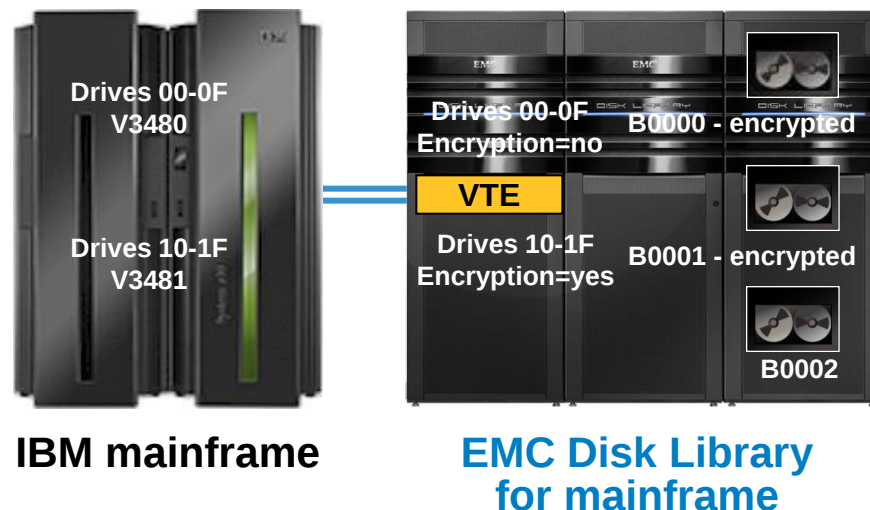
HSM CPU Time Savings



- HSM CPU Time is measured in minutes of actual CPU consumed by HSM
- EMC DLm eliminates the need for HSM on ML1, totally eliminating the CPU cycles consumed by ML1 & reducing “data thrashing”
- EMC DLm reduces HSM ML2 CPU cycles due to fast I/O
- EMC has measured savings up to 70% with heavy ML1 elimination

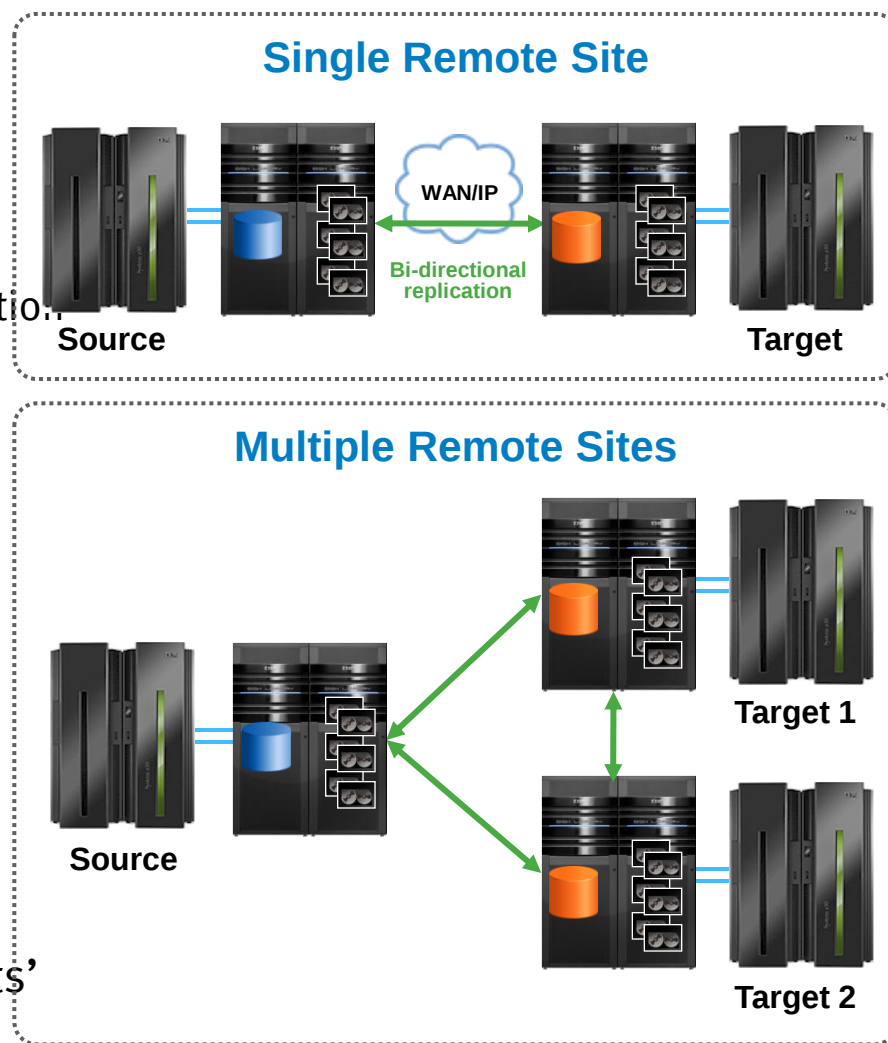
Disk Library for Mainframe Encryption

- Mix encrypted and non-encrypted information in the same Disk Library for mainframe system
- Two options for supporting encryption
 - Using IBM's MTL support under SMS
 - Define two separate MTLs—one with the encrypted devices and one with the non-encrypted devices
 - Define unit information module
 - Unit = V3480: tapes will not be encrypted
 - Unit = V3481: tapes will be encrypted

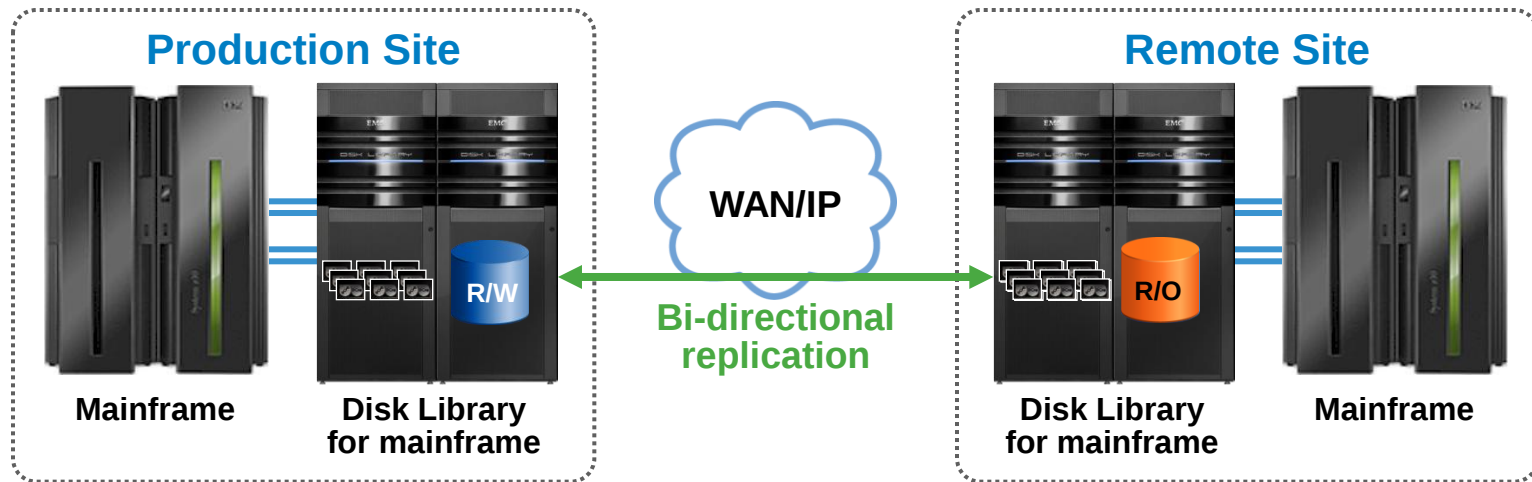


Flexible Remote Replication

- Reduce current tape recovery point objective (RPO)
 - From days to hours or minutes
- No performance penalty on mainframe host
- Back-end storage IP replication
 - Asynchronous replication & guaranteed replication on tape close
 - Only changes are replicated
 - No channel extension required
 - Connect to existing IP Network
- Flexible replication configurations
 - Replicate to one or two sites
 - Replicate all or some of the data
 - Based on VOLSER ranges
 - Bi-directional replication
 - Different RPOs for different VOLSER ranges
- Unique DR testing capability using ‘snapshots’ without disrupting replication



Testing the Disaster Recovery Environment



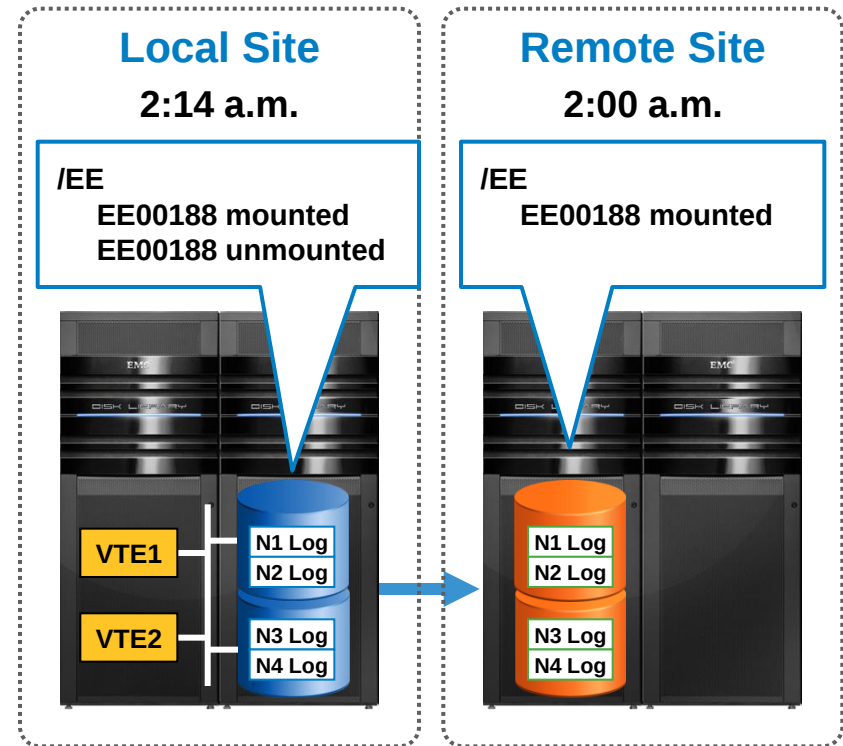
Two ways to conduct disaster recovery testing from copy of production data:

- Read-only mounts
 - Disk arrays allow instant “read-only” copies
 - Confirm that tapes can be mounted and all required data can be accessed
 - No incremental storage capacity required
- Snapshots
 - Disk arrays allow creation of “read only” or “read/write” snapshot
 - Confirm operation at the disaster recovery site
 - Some incremental storage capacity required

Remote replication is uninterrupted

Tape Status Management

- Disk Library for mainframe manages internal logs and maintains the status of the tape volumes
 - Each log will maintain status of specific VOLSER range
 - When a VOLSER is changed (mounted, unmounted), Disk Library for mainframe will write a record in the relevant log file, indicating the change for the specific VOLSER
 - Changes to a VOLSER can be done from any VTE
- Logs are maintained in the Disk Library for mainframe storage
- These log files will be replicated to the remote site along with the tape volumes
- Provides status of all tape volumes inside the Disk Library for mainframe at any given time, both local and remote Disk Library for mainframe systems
 - Can be used as part of disaster recovery operations



Guaranteed Replication

2:00 AM



2:12 AM



2:30 AM



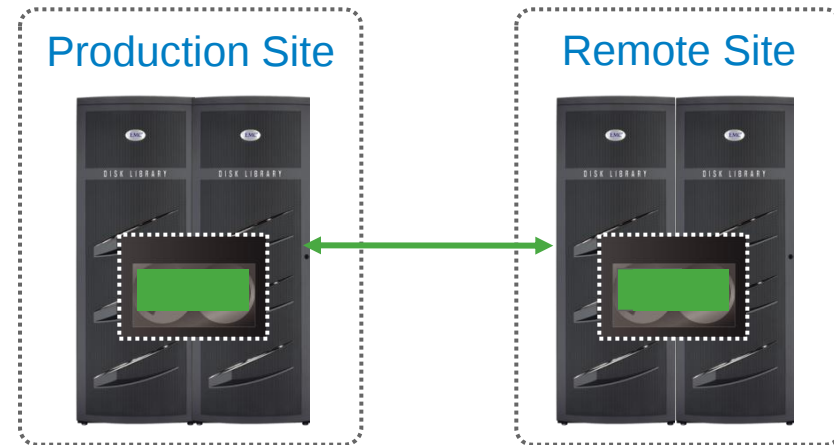
2:35 AM



2:40 AM



- 2:00 AM – DLM replication starts based on RPO
- 2:12 AM – Backup job starts
 - Backing up 100 GB dataset (will create a 30 GB tape)
- 2:30 AM – next DLM replication cycle starts based on RPO
 - Backup tape is being replicated
 - First 25 GB of tape are replicated
- 2:35 AM – Backup job ends
 - “rewind unload” command is sent to the DLM
 - DLM forces replication
 - Last 5 GB of the backup tape are replicated
- 2:40 AM – replication is complete
 - Return control to the mainframe host to finish the backup job



Management for Disk Library for Mainframe: Batch reporting via Mainframe host

- **Command Processors** feature “Command Passing Facility”
- Use JCL to retrieve information about Disk Library for mainframe
 - Easy way of managing DLM from the mainframe host
 - Retrieve the following information:
 - Space used and available
 - Compression
 - Configuration
 - Paths
 - Paths assigned
 - Channel adapters
 - Rejected paths
 - Performance information
 - Slowest mounts
 - Replication status
 - DR recovery tape-in-use logs
 - DLM log files

```
Display Filter View Print Options Help
-----
SDSF OUTPUT DISPLAY DPHILL6A J0004030 0510 104 LINE 0 COLUMNS 02- 81
COMMAND INPUT ==>
***** TOP OF DATA *****

Tape library space for drives: 2100-210F

Path                Size      Active    Scratch / Qty      Free      Filesystem
-----
/tapelib/           17G      1.8K 0%      0 0%      0 14.6G 85% LABEL=root
/tapelib/B1         252.1G    2K 0%     17.1K 0%    95 252.1G 99% 192.168.200
/tapelib/B4         252.1G    1.3K 0%     17.4K 0%    97 252.1G 99% 192.168.200
/tapelib/B2         252.1G    1.6K 0%     17.2K 0%    96 252.1G 99% 192.168.200
/tapelib/B3         252.1G    1.3K 0%     17.4K 0%    97 252.1G 99% 192.168.200
-----
Totals:             1T      0K 0%    69.2K 0%   385 1023G 99%
***** BOTTOM OF DATA *****
```

```
//COMMAND EXEC PGM=DLMCMD
//STEPLIB DD DISP=SHR,DSN=user.apf.loadlib
//DLMCTRL DD UNIT=/xxxx,DISP=SHR,LABEL=(,SL),
//          DSN=DLM.CMDPASS.EXAMPLE,VOL=(,RETAIN,SER=zzzzzz)
//SYSUDUMP DD SYSOUT=*
//DLMLOG DD SYSOUT=*
//DLMCMD DD *
RUNWAIT (600) 501 'DLM command' 'output destination path' 'output file'
/*
```



Mainframe Tape Solutions

Data Deduplication Options

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Mainframe application use cases

There are two distinct use cases for mainframe tape

- **Primary Storage**

- Batch jobs
- Minimal Data redundancy
- Retention periods of just hours
- Equivalent read/write transactions

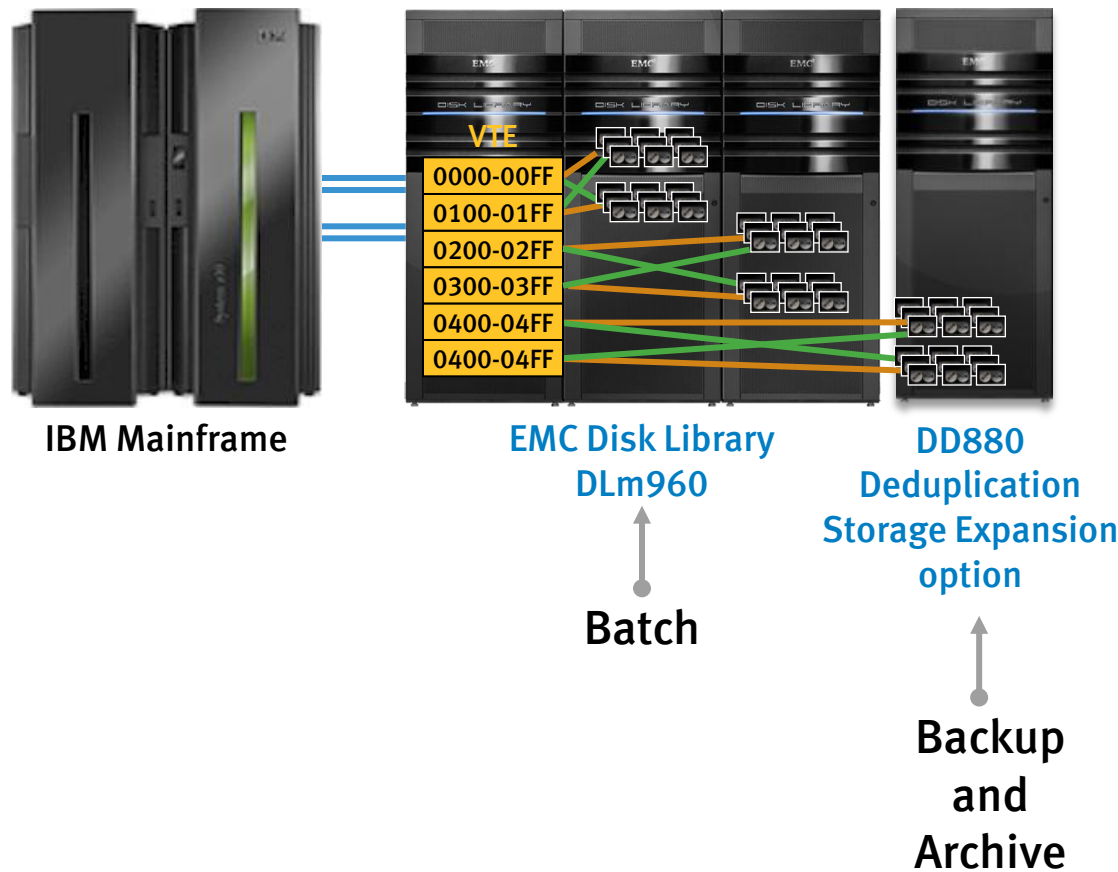
DLm960

- **Secondary Storage**

- Backup applications
- Highly redundant data
- Retention periods of weeks and months
- High writes and low read transactions

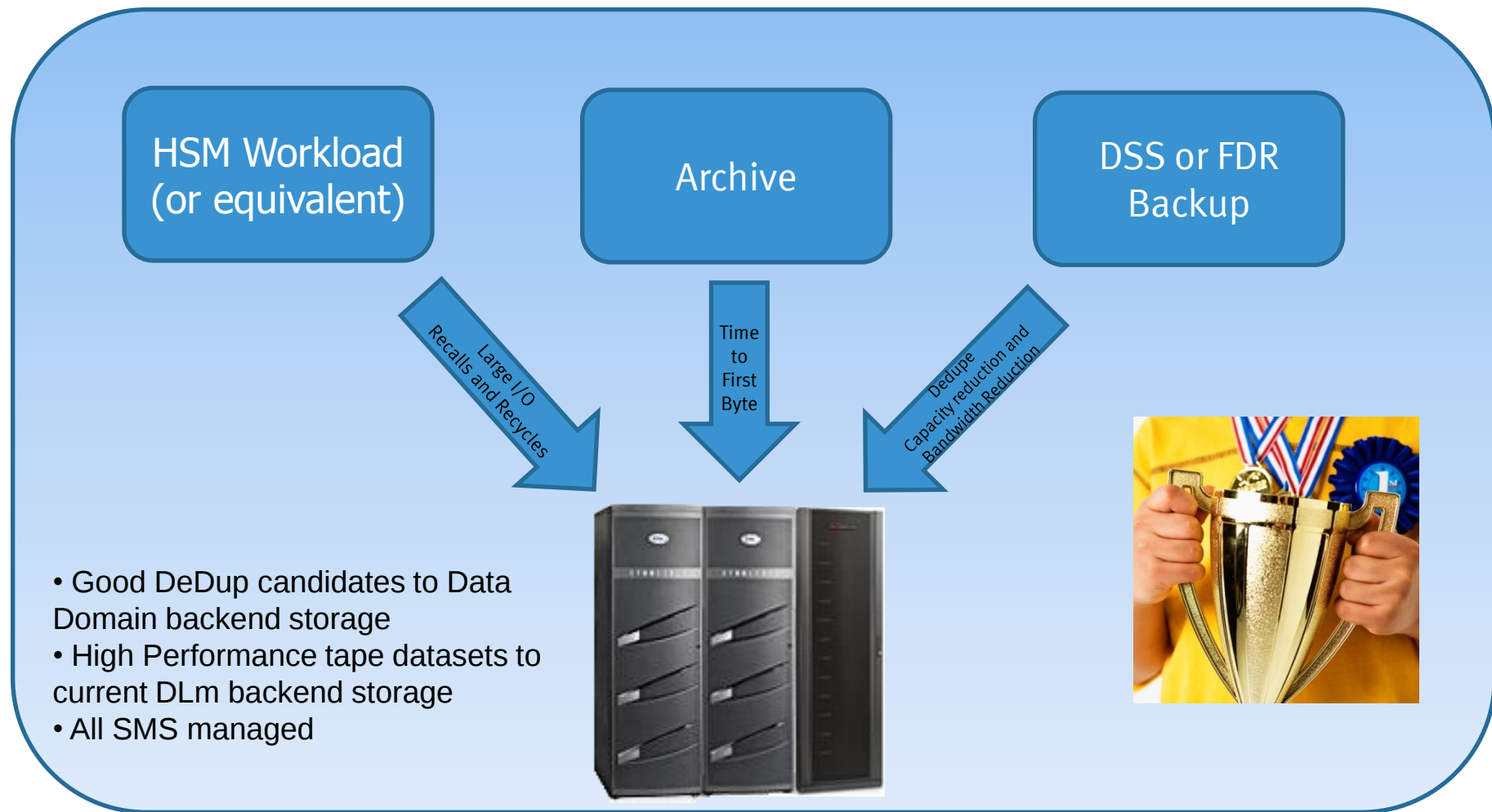
DD880

DLM & Data Domain Dedupe



- Integrate Data Domain storage, with Dedup, into existing DLM960
- Definition Options:
 - 1) Define DLM as multiple MTL's and SMS manage where specific workload output is to be written
 - 2) Define UCB ranges for standard 3480, 3490, and 3590 (and/or esoterics) for workload placement
- Replicate selected volser's / file systems
- DD880
 - Single Storage Array
 - 2-6 ES20 storage shelves
 - 71 TB's in ~12 TB increments (minimum 23TB) RAID-6,
 - 5.4 TB's/ hour

Direct all Mainframe Tape Workloads to the Appropriate MTL's Within DLM



Mainframe Data Domain Solutions

MDL-1000



MDL-2000



DD OS 5.0



DD630



DD670



DD880



DD890

Future Release

Bus-Tech MDL-1000 with DD630

- Single Channel (FICON) MDL
 - 2U Rack-Mountable chassis (Intel SR2600)
 - 6 Gigabit Ethernet ports
 - 1 FICON Interface
 - One or two MDL-1000s (throughput, redundancy)
- Up to 32 Emulated Drives
- Support for DD630
- 170 MBs/sec for 1 MDL-1000
- 320 MBs for 2 MDL-1000s.



2 MDL-1000s w/ DD630
HA w/ 2 FICON
~ 200 - 260 MBs/sec
Up to 64 Drives
Up to 12 TB

Bus-Tech MDL-2000 with DD670

- Dual Channel (FICON) MDL
 - 2U Rack-Mountable chassis (Intel SR2600)
 - Dual Port 10 Gig E (Optical) Intel HBA
 - 2 FICON Interfaces
 - One or two MDL-2000s (throughput, redundancy)
- Up to 64 Drives
- DD670 Support
- 338 MB/sec for 1 MDL-2000.
- 552 MB/sec for 2 MDL-2000s.



2 MDL-2000s w/ DD670
HA w/ 4 FICON
~ 700 MBs/sec
Up to 128 Drives
Up to 76 TB

Mainframe Tape Solutions

Tape Assessment, Analysis, Migration, & Implementation

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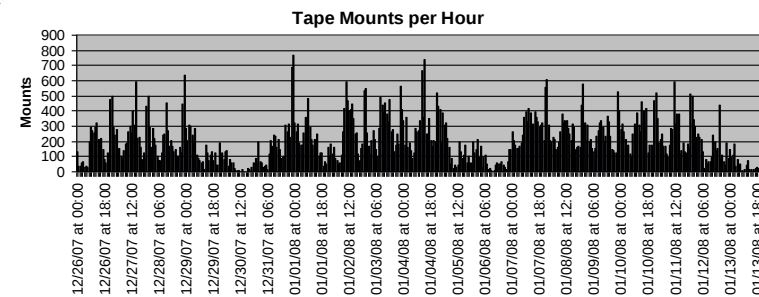
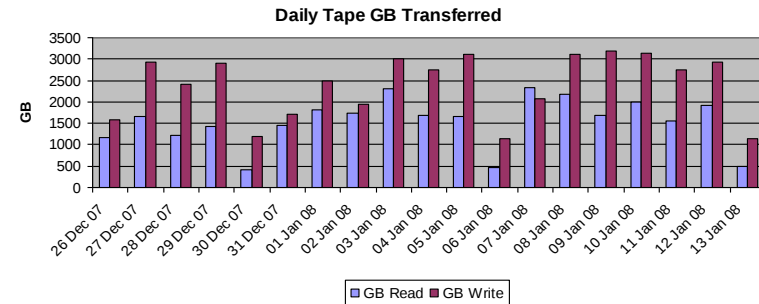
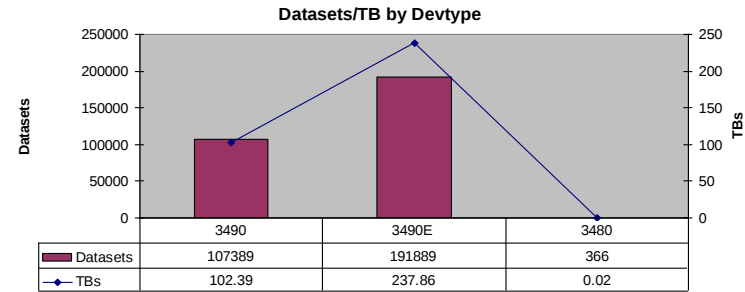


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Never trust a computer you can lift!

“It All Starts with Tape Assessment”

- A comprehensive analysis of the current tape environment; data sources include:
 - System log data (optional)
 - Tape device configuration
 - TMS catalog data (TLMS, CA1-TMS, RMM, Control-T, or ZARA)
 - SMF data—record types 21, 30_2, 73
 - HSM
 - FSR 241
 - ARCCMDxx
 - MCDS – DCOLLECT ‘M’ records
- Report of the summary of findings:
 - Tape Mount and Transport Activity
 - Tape Library Analysis
 - Tape Bandwidth Analysis
 - Best candidates for Data Deduplication



EMC Planning and Implementation: Disk Library for Mainframe - Level 1/2/3 Architecture



- Detailed information-gathering methodology
 - Architect a solution for multiple years
 - Tape assessment
 - Throughput, and storage, channel, and network capacity required
 - Position for future replication, disaster recovery
- Create detailed requirements document
 - FICON/ESCON connectivity, network connectivity, environmental
- Implementation and project plan
 - Migration analysis
- Operational process development
- Test and acceptance plan
- Ongoing capacity planning

Level 3 Architecture – End State Design

(It all starts with Tape Assessment)

Site 1

ITC
HPLEX

4-VTE's - FICON
with 323TB of
Physical Storage
34 DAEs @ 9.5 ea

2 NS80s each with
3 Data Movers
(2 Active/1 Passive)
2 Control Stations

H003
3

H019
19

H016
16

FICON
Directors



Campus Fiber Connected



4-VTE's - FICON
with 323TB of
Physical Storage
34 DAEs @ 9.5 ea

2 NS80s each with
3 Data Movers
(2 Active/1 Passive)
2 Control Stations

Site 3

4-VTE's FICON
With 95TB of
Physical Storage
10 DAEs @ 9.5 ea

APLEX
ZPLEX
BPlex
DRPLEX

A004
4/12

A005
5

A010
10/11



1 NS80
2 Data Movers
1 active /1 passive
2 Control Stations

Bi-Directional IP Replication

IP Replication

Migration Analysis



- Determine best way to introduce Disk Library for mainframe to environment
- Let tape data expire normally
 - X percent of data expires in Y days
- Redirect HSM tape data (or similar data)
 - Point HSM MIGRAT and BACKUP tape data to Disk Library for mainframe
 - Backup and migrate data expires on old media
 - Recycle processing occurs releasing old media
- Migrate other tape information
 - Use host based tool (OpenTech Tape/Copy, CA COPYCAT, 21st Century Software Tape Assist, IDP FATSCOPY, or similar utility) to move the remaining tape data

DLm TCO/ROI Analysis

- Cost considerations
 - Floor space
 - Tape vaulting costs
 - Cost of new tape media
 - Power and cooling
 - Software costs (HSC/LMU)
 - CPU savings for elimination of ML1
 - Reduction on batch window
 - Schedule/unscheduled maintenance windows
 - WAN costs for replication



Customer Name
MVS Tape Refresh Financial Analysis
11/6/2008

Removed equipment

Equipment Removed	Model	Units Installed	Unit Monthly Maint.	Total Monthly Maint.	Power kWh	Cooling kWh	Total Power kWh	Monthly Power Cost
LSM	9310	6	\$1,166.67	\$7,000.00	1.1	0.4	8.8	\$544.67
SL8500	8500	1	\$2,100.00	\$2,100.00	1.1	0.4	1.5	\$90.78
LCU	9311	6	\$1,000.00	\$6,000.00	1.1	0.4	8.8	\$544.67
STD-CAP / E-CAP		6	\$500.00	\$3,000.00	0.5	0.2	4.0	\$247.58
Library Management Unit	9330	3	\$400.00	\$1,200.00	0.6	0.2	2.4	\$148.55
Pass Through Port	4221	10	\$45.00	\$450.00	0.1	0.0	1.3	\$82.53
Virtual Storage Manager	VSM4	3	\$1,646.00	\$4,938.00	3.6	1.2	14.5	\$898.71
Virtual Storage Manager	VSM3	0	\$1,850.00	\$0.00	2.2	0.7	0.0	\$0.00
Drive Frame	9840	11	\$350.00	\$3,850.00	0.0	0.0	0.0	\$0.00
Drive Frame	9490	13	\$350.00	\$4,550.00	0.0	0.0	0.0	\$0.00
Drives	9840	102	\$150.00	\$15,300.00	0.1	0.0	13.6	\$841.77
Drives	9490	52	\$125.00	\$6,500.00	0.4	0.1	27.7	\$1,716.55
Software	HSC/SMC	3	\$1,000.00	\$3,000.00	0.0	0.0	0.0	\$0.00
Software	VTCS	3	\$1,000.00	\$3,000.00	0.0	0.0	0.0	\$0.00
Software	EXLM	3	\$500.00	\$1,500.00	0.0	0.0	0.0	\$0.00
Software	EXPR	3	\$500.00	\$1,500.00	0.0	0.0	0.0	\$0.00
Sub Total				\$63,888.00				\$5,115.82
Personnel with Burden	Librarian	3	\$5,000.00	\$15,000.00	0.0	0.0	0.0	\$0.00
Vault Cart. cost	Carts.	2,700	\$0.17	\$459.00	0.0	0.0	0.0	\$0.00
Replacement Cart. Cost	New	500	\$6.25	\$3,125.00				
Equipment Floor Space	Sq Feet	1,000	\$83.33	\$83,333.33	0.0	0.0	0.0	\$0.00
Sub Total				\$101,917.33				\$0.00
Total				\$165,805.33				\$5,115.82

Equipment Proposed	Model	Units Installed	Unit Monthly Maint.	Total Monthly Maint.	Power kWh	Cooling kWh	Total Power kWh	Monthly Power Cost
DLm4080 Source	437 TB Raw	1	\$11,948.23	\$11,948.23	28.2	9.3	37.5	\$2,327.25
DLm4080 Target	361 TB Raw	1	\$11,948.23	\$11,948.23	24.7	8.2	32.9	\$2,038.40
Floor Space S & T	Sq Ft 11 Frames	75.46	\$83.33	\$6,288.33	0.0	0.0	0.0	\$0.00
Software	Source & Target	1	\$4,895.00	\$4,895.00	0.0	0.0	0.0	\$0.00
Total				\$35,079.79				\$4,365.65

Maintenance Discount 0% kWh \$0.085

DLm

EMC Hardware/Software	\$3,005,183	Capital
Services	\$180,990	Expense
Prepaid SW Maint.	\$176,218	
Total	\$3,362,391	

ROI

Project	Year 1	Year 2	Year 3	Year 4	Year 5	Avg Month	Total
One Time	\$3,362,391	\$0	\$0	\$0	\$0	\$0	\$3,362,391
Cost New Maint	\$75,460	\$75,460	\$75,460	\$420,958	\$420,958	\$17,805	\$1,068,295
Cost New Power	\$52,388	\$52,388	\$52,388	\$52,388	\$52,388	\$4,366	\$261,939
Total	\$3,490,239	\$127,848	\$127,848	\$473,345	\$473,345	\$22,171	\$4,692,625
Savings							
Cost Current Maint	\$1,989,664	\$1,989,664	\$1,989,664	\$1,989,664	\$1,989,664	\$165,805	\$9,948,320
Cost Current Power	\$61,390	\$61,390	\$61,390	\$61,390	\$61,390	\$5,116	\$306,949
Other Incentives	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total	\$2,051,054	\$2,051,054	\$2,051,054	\$2,051,054	\$2,051,054	\$170,921	\$10,255,269

Real Customer TCO/ROI

5 YEAR CONSOLIDATED TCO AND ROI FOR Customer xyz

Project	Initial Investmer	Year 1	Year 2	Year 3	Year 4	Year 5	Avg Month	Total
Hardware	\$ 921,147	\$ -	\$ 96,637	\$ 57,892	\$ 28,946	\$ 28,946	\$ 4,425	\$ 1,133,568
Cost SW Maintenance	\$ -	\$ 20,700	\$ 37,920	\$ 37,920	\$ 37,920	\$ 37,920	\$ 2,873	\$ 172,380
Cost HW Maintenance	\$ -	\$ -	\$ -	\$ -	\$ 134,654	\$ 205,254	\$ 5,665	\$ 339,908
Other costs (Power, Floor space)	\$ -	\$ 46,576	\$ 46,576	\$ 46,576	\$ 46,576	\$ 46,576	\$ 3,881	\$ 232,882
services costs	\$ 150,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 2,500	\$ 150,000
Total	\$ 1,071,147	\$ 67,276	\$ 181,133	\$ 142,388	\$ 248,096	\$ 318,696	\$ 19,345	\$ 2,028,738
Savings								
Cost Current Maintenance		\$ 754,570	\$ 754,570	\$ 754,570	\$ 754,570	\$ 754,570	\$ 62,881	\$ 3,772,849
Cost Current Power		\$ 30,811	\$ 30,811	\$ 30,811	\$ 30,811	\$ 30,811	\$ 2,568	\$ 154,053
Host based tape emulation (VTFM, CA Disk)		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
HSM		\$ 365,000	\$ 365,000	\$ 365,000	\$ 365,000	\$ 365,000	\$ 30,417	\$ 1,825,000
Other savings (off site, software, channel extension, SW licenses)		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ -	\$ 1,150,380	\$ 1,150,380	\$ 1,150,380	\$ 1,150,380	\$ 1,150,380	\$ 95,865	\$ 5,751,902
Annual Project Savings	\$ (1,071,147)	\$ 1,083,104	\$ 969,247	\$ 1,007,992	\$ 902,284	\$ 831,684	\$ 76,520	\$ 3,723,164
Cumulative Cash Flow	\$ (1,071,147)	\$ 11,957	\$ 981,204	\$ 1,989,196	\$ 2,891,480	\$ 3,723,164		
Cumulative Costs	\$ 1,071,147	\$ 1,138,423	\$ 1,319,557	\$ 1,461,945	\$ 1,710,042	\$ 2,028,738		
Cumulative Savings		\$ 1,150,380	\$ 2,300,761	\$ 3,451,141	\$ 4,601,522	\$ 5,751,902		

* Does not include Net Present Value, Cost of Terms, Currency Devaluation, or Tax

* Includes Freight & Hardware Installation

Recovery Months **12**

5 year ROI **184%**

Costs vs. Savings

Large Midwestern Healthcare Company

- Large Mainframe Environment on STK. 6 PB of Tape Data. 100% Replicated. \$80B company.
- Customer: “We are in no hurry to replace aging STK”.
- Customer was aware of the successful implementation of MDL at other very large Bank.
- DR site is 10 miles away and had indicated an eventual need for 3rd full DR site.
- 50% of Data was HSM. Through a tape analysis completed by EMC we saw almost 3000 HSM recalls per day in one LPAR. Averaged 85 seconds per recall. Determined this was “EOB” data over 30 days old. On HSM because “cost center not charged if rolled to tape”. Consuming over 12 FTE waiting for recalls; Customers on the line waiting too.
- ROI showed rapid return on investment. Based on service cost of old tape systems, channel extension gear, FTE for recall, data center space, and power.
- Original deal was (2) DLM with 1.3 PB of “usable” tape capacity (after compression).
- Customer reports 0.01 second average response time to HSM recalls.
- Customer buying second half of DLM system in Q1 2011.
- Customer indicates they “love the DLM”.
- Customer indicates their mainframe tape capacity will “Quadruple over the next 3 years due to healthcare reform.” That is exclusive of the proposed 3rd data center.

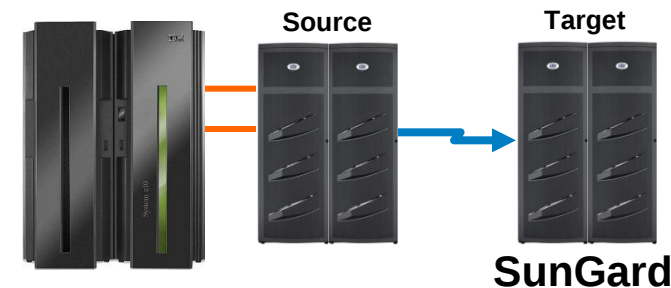
OAM Application serving online, real time customer inquiries

- Challenges:

- Were writing archive data with OAM to SUN/STK tape libraries with high capacity drives and also had IBM VTS with 3494 libraries. Managing two separate tape environments.
- Mount times with OAM retrievals were erratic and sometimes timed out.
- Creating 2 and 3 copies of data on tape to minimize data loss exposure.
- Regulatory agencies were mandating encryption for 'ALL' offsite tapes
- Directive from upper management to reduce or get off tape
- Concerned with potential loss of tapes with personal & confidential customer information.
- Floor space, KVA's, & BTU's consumed with tape based solutions
- The normal problems every customer faces with tape media problems/issues/exposures

- Solution:

- Started with 95TB DLM replicated to 95TB DLM – Target located in SunGard
 - Current config now at 190TB replicated to 190TB
- Before and after measurement:
 - Before = 28826 millisecond response time (28.826 seconds)
 - After = 561 millisecond response time (1/2 a second)
- RPO lowered from 24-36 hours to less than 1/2 hour



Real Customer Measured Improvements/Savings

- **Measured after Replicated DLm960 Implementation:**
 - Reduced HSM's Total CPU Time by 19 hours, 45 minutes
 - 13.44% REDUCTION in Total CPU Time used for HSM Migration to L2 even though the number of Megabytes transferred increased by over 6TB or 680,000 data sets
 - 64.39% REDUCTION in Average CPU Time used for HSM L2 RECALLS
 - 91.71% REDUCTION in Average ELAPSE Time for L2 RECALL
 - 53.09% REDUCTION in Total CPU Time used to RECYCLE HSM BACKUP
 - 26.73% REDUCTION in Total CPU Time used for DAILY BACKUP
 - 55.19% REDUCTION in Total ELAPSE Time used for DAILY BACKUP even though the backup workload increased
 - REDUCTION in duplicate recall requests (RC2 errors) from 2,431 to 264
 - REDUCED all errors in HSM for this period by 74,741

Why EMC “Tape on Disk”

- Value of tape data written/stored on disk:
 - Every “read”/write is at disk speed
 - RAID-6 protected tape data
 - Data is more secure, no need to encrypt
 - HSM savings
 - CPU savings
 - Small footprint
 - Huge bandwidth savings (real \$\$'s)
 - Flexible IP replication
 - Ease of DR testing
 - Return home after “Declared Disaster” is doable
 - TCO/ROI better than tape
 - Coexists with real tape if needed
- *Note: Tape data written to physical tape will not have the benefits of tape data written to ‘tape on disk’. The entire industry is aggressively minimizing or completely eliminating tape media usage.*

EMC DLM and Dedup Benefits

Operational

- Eliminate tape handling
- Reduce tape batch processing times
- No JCL changes
- No started task needed
- No SW installed on MF
- Built-in IP based replication for D.R
- Multi-site disaster recovery
- Ultra-safe storage for reliable recovery
- Operational simplicity
- Massive data reduction *

Financial

- Eliminate tape maintenance
- Eliminate tape media purchases & racks
- Reduce power costs
- Reduce CPU cycles
- Reduce cooling costs
- Reclaim floor space
- Reduce or eliminate off-site tape storage costs
- Reduce # of host FICON / ESCON channels
- Reclaim expensive Tier 1 storage by eliminating ML-1, TMM, VTFM, CopyCross, etc..
- Eliminate expensive channel extension gear (if used)

Performance

- Much Faster than tape
- Faster recoveries
- Reduce MF compression cycles
- Reduce CPU cycles
- Address specific batch performance issues
- Easy scalability – uses low cost / high performing SATA II disks
- RAID-6 protection
- IP replicate unique / de-duplicated data *
- Reduce WAN resources *

The logo features the text "EMC²" in a large, dark blue, serif font. A small registered trademark symbol (®) is located at the bottom right of the "C". The background is a light blue gradient with a bright sunburst effect emanating from behind the text.

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